

METHOD FOR MANUFACTURING AIRTIGHT CONTAINER,  
METHOD FOR MANUFACTURING IMAGE DISPLAY APPARATUS, AND  
AIRTIGHT CONTAINER AND IMAGE DISPLAY APPARATUS

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an airtight container, and an image display apparatus which uses the same. The invention relates to an airtight  
10 container in which the inside is maintained in a lower pressure state than the outside.

Related Background Art

In recent years, a color cathode ray tube (CRT) has been used in wide as an image display apparatus.  
15 However, since a driving principle is a system of deflecting an electron beam from a cathode, and emitting a light from a phosphor on a screen, a depth must be set in accordance with a screen size. As a screen is enlarged, a depth is made longer, which  
20 creates problems of increases in installation space and weight etc. Therefore, there is a strong demand for a planar image display apparatus which can be made thin and light. As examples of planar image display apparatus, there are an electron emission  
25 display panel of a surface conductive type (referred to as SED hereinafter) (Japanese Patent Application Laid-Open No. H09-045266), and a field emission

display apparatus (referred to as FED hereinafter)  
(Japanese Patent Application Laid-Open No. H05-  
114372).

Fig. 11 shows in outline the planar image  
5 display apparatus described in Japanese Patent  
Application Laid-Open No. H05-114372. A front panel  
2 on which a power supply conductive layer 6 is  
formed as an anode electrode, a back panel 3 on which  
a cathode electrode 7 is disposed, and an insulating  
10 layers 8, 28 are pinched in, and sealed. Then, an  
atmosphere is sucked out of the inside through an  
exhaust pipe (not shown in the figures) by a pump,  
sealing is applied, and a vacuum structure is formed.  
Accordingly, a superthin planar display apparatus 20  
15 is manufactured. A voltage is applied between the  
power supply conductive layer 6 and the cathode  
electrode 7 to emit electrons from the cathode  
electrode 7. By the emitted electrons, a light is  
emitted from a fluorescent screen to form a pixel,  
20 and an image is displayed on the front panel 2. At  
this time, in order to apply a voltage to the power  
supply conductive layer 6, a fluorescent screen  
potential power supply terminal 16, an elastic body  
19 and the power supply conductive layer 6 are used  
25 through a terminal lead-out section 17 from a hole 15  
bored in the back panel 3. Therefore, vacuum-sealing  
of a seal body 18 which covers the terminal lead-out

section is necessary.

Japanese Patent Application Laid-Open No. 2000-195449 discloses a vacuum container used in an image display apparatus. Fig. 16 of this publication shows  
5 a constitution in which an elastic spring member is deformed by a vacuum force, and a high-pressure introduction terminal is directly pulled out to be connected on a wiring.

10 SUMMARY OF THE INVENTION

Objects of the present invention are to provide  
1) a novel method for manufacturing an airtight container having an electrode inside, which can easily realize a constitution of supplying a  
15 potential to the electrode, 2) a low-cost airtight container, and 3) a low-cost image display apparatus.

One of the manufacturing methods of airtight containers of the present invention is constituted as follows.

20 That is, according to one aspect of the present invention, there is provided a method for manufacturing an airtight container having a space in which a pressure is lower than the outside, between opposing first and second substrates, comprising  
25 steps of:

assembling the container having the space between the first and second substrates, the first

substrate in which an electrode is disposed on a surface as the space side and the second substrate which has a structure for supplying a potential to the electrode being opposite each other; and

5       applying a pressure difference between the inside and the outside of the container assembled in the above step,

          wherein in the container before the pressure difference application step, the structure has a  
10   concave portion which is opened to an external atmosphere at a through-hole penetrating the second substrate and closed at the bottom, and the pressure difference is brought in the pressure difference application step to elongate lengths of the structure  
15   in direction in which the first and second substrates are opposed, whereby the structure is formed in a shape to enable supplying of a potential to the electrode through the structure.

          In the structure, the portion elongated by the  
20   pressure difference may be formed to be elastic, and this elasticity easily brings temporary or permanent narrowing of a gap between the first and second substrates after the pressure difference application step. Not limited to this, however, the portion may  
25   be plastically deformed by the pressure difference to be elongated.

          The assembling step can be optionally executed.

However, as an example, a constitution can be suitably employed where the assembling step has a step of preparing the first substrate in which the electrode is formed, and a step of preparing the  
5 second substrate in which the structure is disposed, and a step of arranging the first and second substrates oppositely to each other to bond them. A member may be arranged between the first and second substrates to maintain a gap therebetween. As such a  
10 member, a frame arranged to surround the internal space, or a spacer disposed in a proper position in the internal space, an outer periphery of which is defined, can be cited.

The shape to enable supplying of a potential to  
15 the electrode through the structure means that if it is connected to an external potential supply circuit to supply a potential to the structure, the potential is supplied to the electrode through the structure. If the pressure difference application step is  
20 executed while the potential is supplied to the structure, potential supplying is carried out at a point of time when the structure becomes a shape to enable supplying of a potential to the electrode through the structure.

25 For the pressure difference application step, a process can be suitably employed where the container is assembled to enable a pressure reduction inside

through a ventilation section such as an exhaust pipe  
in the assembling step, the airtight container is  
constituted by executing the step of applying a  
pressure difference by degassing the inside through  
5 the ventilation section after the assembling step and  
executing the assembling step in a pressure-reduced  
atmosphere, and then the step of applying the  
pressure difference is executed by exposing the  
container to a higher pressure atmosphere.

10 One of the other inventions is constituted as  
follows. That is, according to another aspect of the  
present invention, there is preferable, a method for  
manufacturing an airtight container having a space in  
which a pressure is lower than the outside, between  
15 opposing first and second substrates, comprising  
steps of:

assembling the container having the space  
between the first substrate in which an electrode is  
disposed on a surface as the space side and the  
20 second substrate which has a structure for supplying  
a potential to the electrode being opposite each  
other; and

applying a pressure difference between the  
inside and the outside of the container assembled in  
25 the above step,

wherein in the container before the pressure  
difference application step, the structure has a

surface of a curved shape between a portion bonded to the second substrate and a portion to be brought into direct or indirect contact with the electrode, and the pressure difference is brought between the inside  
5 and the outside of the surface of the curved shape in the pressure difference application step to deform the surface, whereby the structure is formed in a shape to enable supplying of a potential to the electrode through the structure.

10           The curved shape can be formed by pressing work to bend a noncurved shape or the like. However, it is not limited to the shape formed by bending the solid member of the noncurved shape. For example, a structure having a curved shape may be manufactured  
15 by casting. The surface having the curved shape includes a surface which has a folded shape. The folded shape is not limited to the shape formed by folding an unfolded shape. For example, a folded shape realized by bonding a plurality of members is  
20 included. As one of such curved shapes, a bellows-like configuration can be cited. This configuration can be formed by using pressing work as bending work, or alternately bonding inner and outer diameter ends of a plurality of ring-shaped members.

25           Preferably, the portion to be brought into direct or indirect contact with the electrode and the portion to be deformed of the structure are formed by

bending one plate member, and use of press working as bending work is especially preferable. More preferably, the portion to be brought into direct or indirect contact with the electrode, the portion to be deformed, and the portion of the structure bonded to the second substrate are formed by bending one plate member.

The whole structure which supplies the potential to the electrode disposed in the first substrate, or a part thereof which becomes a potential supply path is preferably constituted of a conductor. A metal (including alloy) can be suitably used for the conductor. In the case of forming a plurality of portions by being one plate member as in the above, a metal plate is preferably used as the plate member.

The manufacturing method of the airtight container of the present invention can be suitably used for manufacturing an image display apparatus which has the airtight container.

Specifically, it is advised to implement the manufacturing method of the airtight container after an electrode for constituting an image display device or an image forming device is formed beforehand in one of the first and second substrates or in a position on the internal space side of both.

An airtight container of the present invention



is constituted as follows.

That is, according to a further aspect of the present invention, there is provided an airtight container comprising:

5       a first substrate in which an electrode is disposed;

          a second substrate which is opposite the electrode-disposed surface of the first substrate; and

10       a structure which is bonded to the second substrate, and brought into direct or indirect contact with the electrode to supply a potential to the electrode,

          wherein in the structure, a portion deformed by  
15 a lower pressure in an internal space between the first and second substrates than a pressure of an external atmosphere and a portion brought into direct or indirect contact with the electrode are formed by bending one plate member.

20       The bonding of the structure to the second substrate may be executed directly or indirectly to the substrate.

          The structure may be brought into contact with the electrode directly or indirectly through a metal  
25 (including alloy) more flexible than the electrode. Additionally, the structure may be bonded by a conductive adhesive. As the adhesive, preferably, a

constitution in which the structure is bonded to the electrode by using a molten metal in a solid form is employed.

An airtight container of the other invention is  
5 constituted as follows.

That is, according to still another aspect of the present invention, there is provided an airtight container comprising:

a first substrate in which an electrode is  
10 disposed;

a second substrate which is opposite the electrode-disposed surface of the first substrate; and

a structure which is bonded to the second  
15 substrate, and brought into direct or indirect contact with the electrode to supply a potential to the electrode,

wherein the structure is bonded to a surface of the second substrate opposite the first substrate at  
20 a through-hole penetrating the second substrate, and the structure has a concave portion which is opened at the through-hole to an external atmosphere to an internal space formed between the first and second substrates and closed at the bottom, and a portion in  
25 which a surface opposite a surface bonded to the second substrate is exposed to the external atmosphere as a portion bonded to the surface of the

second substrate opposite the first substrate.

According to a further aspect of the present invention, there is provided an image display apparatus which comprises: the airtight container of  
5 the invention; and an image display device arranged in the airtight container.

As the image display device, for example, an electron emitting element can be suitably used. In the case of using the electron emitting element as  
10 the image display device, a phosphor which emits a light by electrons emitted from the electron emitting element may be further arranged. As an example, a constitution can be suitably employed where the electron emitting element is disposed in one of the  
15 first and second substrates, and the phosphor is arranged in the other substrate. In the case of using the electron emitting element, a constitution can be suitably employed where an electrode to which an acceleration potential for accelerating emitted  
20 electrons is arranged inside. As the electrode disposed in the first substrate of the present invention, the electrode to which the acceleration potential is supplied or a drawer electrode drawn out of the electrode can be cited. In this case, the  
25 structure may be arranged to supply the acceleration potential to the electrode. The image display device is not limited to the above constitution, but an

electroluminescence device, a plasma cell to constitute a plasma display etc., can be employed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5        Fig. 1 is a schematic plan view showing an embodiment of an image display apparatus.

Fig. 2 is a schematic partial sectional view showing an embodiment of a vacuum container of the present invention.

10       Fig. 3 is a schematic partial sectional view showing an example of a voltage supplying structure.

Figs. 4A, 4B and 4C are process views showing a manufacturing method of the voltage supplying structure shown in Fig. 3.

15       Fig. 5 is a schematic partial sectional view showing a voltage supplying structure of a second embodiment.

20       Figs. 6A, 6B and 6C are process views showing a manufacturing method of the voltage supplying structure of the second embodiment.

Fig. 7 is a schematic partial sectional view showing a voltage supplying structure of a third embodiment.

25       Figs. 8A and 8B are process views showing a manufacturing method of the voltage supplying structure of the third embodiment.

Fig. 9 is a schematic partial sectional view

showing a voltage supplying structure of a fourth embodiment.

Figs. 10A, 10B and 10C are process views showing a manufacturing method of the voltage  
5 supplying structure of the fourth embodiment.

Fig. 11 is a schematic view showing a conventional image display apparatus.

#### PREFERRED EMBODIMENTS OF THE INVENTION

10 Figs. 1 and 2 show in outline a first embodiment of the present invention. An airtight container 106 can be manufactured by arranging a face plate 101 comprising an anode 104 on a plane and a rear plate 102 comprising a cathode 1001 on a plane  
15 oppositely to each other, pinching in a frame 103 and a spacer 1002 therebetween, and bonding the plates. The cathode 1001 is an electron emitting element which is an image display device, and electrons emitted from the electron emitting element are  
20 accelerated by an acceleration potential applied to the anode which is an acceleration electrode. This airtight container is a vacuum container which is set to  $10^{-4}$  Pa or lower inside (airtight container is referred to as a vacuum container, hereinafter). By  
25 holding the cathode in the vacuum container, the cathode can function as an electron source. In the vacuum container, a drawer wiring (not shown) is laid

from the cathode in the vacuum container on the rear plate 102, and extended to the outside of the frame 103. The cathode is controlled by a driving device 150 through a drawer cable 110 which is made  
5 electrically conductive by a trailing end of the drawer wiring. The anode is controlled by a voltage supplying device 160 through a voltage supplying structure 100 which includes a later-described structure of the present invention, and a voltage  
10 supplying cable 161 attached to the voltage supplying structure by a connector (not shown). A potential applied from the voltage supplying device 160 is supplied to the structure, and supplied through the structure to the anode which is an acceleration  
15 electrode. Then, by controlling the cathode and the anode in the vacuum container 106 in such a manner, an image can be formed in an image display apparatus 105. The face plate 101 and the rear plate 102 respectively constitute first and second substrates,  
20 which can be made of, e.g., glass. A pressure inside the vacuum container of the image display apparatus 105 is lower than an external atmosphere, i.e., the inside is in a vacuum state. The face plate 101, the rear plate 102 and the frame 103 are bonded by frit  
25 glass or the like to maintain airtightness between the face plate 101 and the rear plate 102. In the image display apparatus 105, a voltage is applied to

the anode 104 to accelerate electrons which are out of the cathode (not shown) on the rear plate 102 into vacuum, and the electrons collide with a phosphor in the anode 104 to emit a light, thereby forming an  
5 image.

As a power supplying system from an atmosphere to the image display apparatus 105 which is vacuum inside, the voltage supplying structure 100 is provided. The image display apparatus 105 comprises  
10 the aforementioned vacuum container in which the face plate 101, the rear plate 102 and the frame 103 are bonded and which comprises the voltage supplying structure 100, the drawer cable 110, the driving device 150, the voltage supplying cable 161, and the  
15 voltage supplying device 160. Fig. 3 is a partial sectional view cut along the line A-A of Fig. 1. A voltage is applied from the backside of the rear plate 102 through a through-hole (referred to a hole hereinafter) 111 to a conductive member 108, and  
20 applied through a low melting point material 107 to the anode 104. A diameter of the hole is about 2 mm.

The structure of the present invention is constituted of the conductive member 108. The conductive member 108 has, as a portion to be  
25 elongated by a pressure difference, a bellows-like portion which especially has a curved shape, a portion connected to the anode, and a portion bonded

to the rear plate 102. The voltage supplying structure 100 comprises the conductive member 108, the low melting point material 107, and a bonding member 109.

5           The conductive member 108 can be brought into direct contact with the anode 104. Preferably, however, the low melting point material 107 is disposed therebetween. The low melting point material is used as a member to improve conductivity  
10 by enhancing adhesion between the conductive member 108 and the anode 104. The low melting point material is compressed and deformed between the conductive member 108 deformed by an atmospheric pressure and the anode 104, stuck to the surface  
15 shape of the conductive member 108 and the anode 104, and thus capable of improving electrical conductive reliability. At this time, for the low melting point material 107, a conductive material which has a solidus temperature of 100°C or higher as a standard  
20 product use temperature, and a melting point of a temperature 420°C or lower to manufacture the vacuum container can be properly selected. For example, a low melting point metal material can be used. The low melting point metal is used as the member to  
25 improve electrical connection between the conductive member 108 and the anode. For this member, however, a member softer than the anode is preferably used.



This member may be used as a binding material to bond the conductive member 108 and the anode 104.

When the image display apparatus 105 is influenced by an unexpected surrounding temperature to be deformed by thermal expansion, adhesion between the conductive member 108 and the anode 104 may be deteriorated. In such a case, by applying a high-frequency voltage to the conductive member 108, and generating heat to melt the low melting point material 107, it is possible to improve adhesion between the conductive member 108 and the anode 104 without disassembling the image display apparatus 105. The molten low melting point material is solidified by a reduction in temperature to become a member to bond the conductive member 108 and the anode 104.

Vacuum airtightness is secured by using a bonding member 109 to bond the conductive member 108 and the anode 104. As a material of the bonding member 109, for example, a frit which is low melting point glass is used. A mixture of a frit and a solvent is applied on the conductive member 108 by a dispenser, dried (e.g., 120°C, 10 min.), and temporary burning (e.g., 360°C, 10 min.) is carried out. Then, in a real burning step (e.g., 420°C, 30 min.), the conductive member 108 is placed on the rear plate 102, and a load is applied on the conductive member 108 to crush the temporarily burned

frit while a temperature is increased. Thus, good bonding is obtained.

The conductive member 108 is an integral member constituted of an adhesive portion bonded to the rear plate, an elongation portion, and a contact portion brought into contact with the anode through the low melting point metal. As a material, in order to reduce thermal stress during manufacturing, it is advised to select a material of a thermal expansion coefficient which roughly coincides with that of a material used for the rear plate 102. For example, if glass of a thermal expansion coefficient  $8.0 \times 10^{-6}/^{\circ}\text{C}$  to  $9.0 \times 10^{-6}/^{\circ}\text{C}$  is used for the rear plate, a thermal expansion coefficient of the conductive member is preferably  $7.5 \times 10^{-6}/^{\circ}\text{C}$  to  $1.0 \times 10^{-5}/^{\circ}\text{C}$ . The conductive member 108 is bonded to the rear plate 102 by the bonding member 109. Since only one place between the conductive member 108 and the rear plate 102 is a bonded portion of the voltage supplying structure 100, it is possible to limit a probability of leakage or a strength reduction caused by bonding failures. The conductive member 108 can be manufactured by, for example, sucking a plate made of a conductive material in a mold by air, and executing press-molding.

A height of the conductive member installed in the rear plate 102 from its upper surface can be made

smaller than a gap between rear plate 102 and the face plate 101. As shown in Fig. 4A, the conductive member 108 is bonded to the rear plate 102 by the bonding member 109. Then, as shown in Fig. 4B, the  
5 frame is pinched in between the rear plate 102 and the face plate 101, and the rear plate and the frame, and the frame and the rear plate are sealed from each other by frits or the like. Then, a vacuum is drawn through the not-shown exhaust pipe between the rear  
10 plate 102 and the face plate 102, sealing is applied, and accordingly a vacuum container of the image display apparatus is manufactured. At this time as shown in Fig. 4C, since the conductive member 108 is formed in a shape which has a concave portion opened  
15 to an external atmosphere at a hole 111 as a through-hole of the rear plate, and closed at the bottom, i.e., the anode side, it is influenced by a pressure difference between an atmospheric pressure from the hole 111 and a pressure in the internal space to  
20 elongate even a gap length between the rear plate 102 and the face plate 101, and it is brought into indirect contact with the anode 104 through the low melting point material 107. Thus, a shape can be realized which enables supplying of a potential to  
25 the anode as an electrode formed in the face plate 101 from the rear plate side through the conductive member 108. When a potential is supplied to the

conductive member 108 in this state, the potential is supplied through the conductive member 108 to the anode.

As the conductive member to constitute the  
5 structure of the present invention, the portion brought into contact with the anode, the elongated portion and the portion bonded to the rear plate are formed by deforming one plate member. Accordingly, a seal bonding interface of the hole 111 sealing can be  
10 limited to one place, and a probability of bonding failures or leakage can be made small. As a result, yield of the vacuum container 106 and the image display apparatus 105 can be increased, and a more inexpensive image display apparatus 105 can be  
15 provided. The structure before the application of the pressure difference is formed in a shape which has a concave portion opened to the external atmosphere at the hole 111 and closed at the bottom, i.e., the anode side. Thus, the side of the concave  
20 portion can be used as an elongated portion, and a sufficient length to be elongated can be set. Furthermore, by employing the structure of a curved shape as an elongated scheduled portion before the application of the pressure difference, a sufficient  
25 length to be elongated can be set.

[Examples]

Example 1

An image display apparatus of a type shown in Fig. 1 is manufactured, which has a voltage supplying structure shown in Fig. 3, and a vacuum container which is shown in Figs. 1 and 2 and which comprises  
5 the voltage supplying structure.

An airtight container 106 is manufactured by arranging a face plate 101 comprising an anode 104 on a plane and a rear plate 102 comprising a cathode 1001 on a plane oppositely to each other, pinching in  
10 a frame 103 and a spacer 1002 therebetween, and bonding the plates. In this vacuum container, a drawer wiring (not shown) is laid from the cathode in the vacuum container on the rear plate 102, and extended to the outside of the frame 103. The  
15 cathode is controlled by a driving device 150 through a drawer cable 110 which is made electrically conductive by a trailing end of the drawer wiring. The anode is controlled by a voltage supplying device 160 through a voltage supplying cable 161 attached to  
20 the voltage supplying structure 100 by a connector (not shown). Then, controlling of the cathode and the anode in the vacuum container 106 in such a manner is enabled to constitute an image display apparatus 105. The face plate 101 and the rear plate  
25 102 are made of glass of 2.8 mm in thickness. The inside of the image display apparatus is in a vacuum state. Frits (not shown) are used to bond the face

plate 101, the rear plate 102 and the frame 103. Frit paste in which a frit is made claylike by a solvent is applied on the frame 103, dried, burning is carried out in an oven at 420°C for 30 min., while  
5 a pressure is applied, and then bonded. By such bonding, airtightness is maintained between the face plate 101 and the rear plate 102. In the image display apparatus 105, a voltage is applied to the anode 104 to accelerate electrons which are out of  
10 the cathode on the rear plate 102 into vacuum, and the electrons collide with a phosphor (not shown in the figures) in the anode to emit a light, thereby forming an image.

As a power supply mechanism from an atmosphere  
15 to the image display apparatus 105 which is vacuum inside, the vacuum container 106 has the voltage supplying structure 100. Fig. 3 is a partial sectional view cut along the line A-A of Fig. 1. A voltage is applied from the backside of the rear  
20 plate 102 through a hole 111 to a conductive member 108, and applied through a low melting point material 107 to the anode 104.

The voltage supplying structure 100 comprises the conductive member 108, the low melting point  
25 material 107, and a bonding member 109. A diameter of the hole 111 bored in the rear plate is 2 mm.

The low melting point material 107 is disposed

between the conductive member 108 and the anode 104. The low melting point material improves conductivity by enhancing adhesion between the conductive member 108 and the anode 104. As a low melting point  
5 material, an In alloy (melting point 140 to 200°C) of a low melting point metal material is used. The low melting point material is compressed and deformed between the conductive member 108 deformed (elongated) by an atmospheric pressure and the anode  
10 104, stuck to the surface shape of the conductive member 108 and the anode 104 (Fig. 4C), and thus capable of improving electrical conductive reliability.

Further, when the image display apparatus 105  
15 is influenced by an unexpected surrounding temperature to be deformed by thermal expansion, adhesion between the conductive member 108 and the anode 104 may be deteriorated. In such a case, by applying a high-frequency voltage to the conductive  
20 member 108, and generating heat to melt the low melting point material 107, it is possible to improve adhesion between the conductive member 108 and the anode 104 without disassembling the image display apparatus 105.

25 Vacuum airtightness is secured by using a bonding member 109 to bond the conductive member 108 and the anode 104. As a material of the bonding

member 109, a frit which is low melting point glass is used. A mixture of a frit and a solvent is applied on the conductive member 108 by a dispenser, dried (e.g., 120°C, 10 min.), and temporary burning (e.g., 360°C, 10 min.) is carried out. Then, in a real burning step (e.g., 420°C, 30 min.), the conductive member 108 is placed on the rear plate 102, and a load is applied on the conductive member 108 to crush the temporarily burned frit while a temperature is increased. Thus, good bonding is obtained.

The conductive member 108 is an integral member constituted of an adhesive portion of a diameter 4 mm and an elongation portion. A material is a 42Ni-6Cr-Fe alloy (thermal expansion coefficient  $8.5 \times 10^{-6}/^{\circ}\text{C}$  to  $9.8 \times 10^{-6}/^{\circ}\text{C}$ ). The thermal expansion coefficient is roughly matched with that of glass used for the rear plate 102 (thermal expansion coefficient  $8.0 \times 10^{-6}/^{\circ}\text{C}$  to  $9.0 \times 10^{-6}/^{\circ}\text{C}$ ) to reduce thermal stress during manufacturing. The conductive member 108 is bonded to the rear plate 102 by the bonding member 109. Since only one place between the conductive member 108 and the rear plate 102 can be a bonded portion of the voltage supplying structure 100, it is possible to limit a probability of leakage or a strength reduction caused by bonding failures.

The conductive member 108 is manufactured by sucking a plate of about 10 mm in diameter and 0.05



mm in thickness in a mold by air, and executing  
press-molding. A shape is a circle of an outer  
diameter of about 4 mm when the image display  
apparatus 105 is seen from the anode 104 side. A  
5 height is about 0.7 mm, which is smaller than a gap  
length 2 mm between the rear plate 102 and the face  
plate 101. As shown in Fig. 4A, the conductive  
member 108 is bonded to the rear plate 102 by the  
bonding member 109. Then, as shown in Fig. 4B, the  
10 frame 103 is pinched in between the rear plate 102  
and the face plate 101, and the rear plate and the  
frame, and the frame and the rear plate are sealed  
from each other by frits. Then, a vacuum is drawn  
through the not-shown exhaust pipe between the rear  
15 plate 102 and the face plate 102, sealing is applied,  
and accordingly a vacuum container is manufactured.  
At this time as shown in Fig. 4C, the conductive  
member 108 is elongated to the gap length 2 mm  
between the rear plate 102 and the face plate 101 by  
20 a pressure difference between an atmospheric pressure  
from the hole 111 and a pressure in the internal  
space. That is, by the application of the pressure  
difference, the shape of the conductive member 108  
which is a structure is deformed in a shape to be  
25 brought into contact with the anode 104 through the  
low melting point 107.

By disposing a plurality of concave and convex

shapes in the elongation section on the side face of the conductive member 108 by press-molding, it is possible to control deformation of the conductive member 108 by the atmospheric pressure in a direction  
5 of the anode 104. As a result, it is possible to improve conductive reliability between the conductive member 108 and the anode 104.

#### Example 2

A vacuum container and an image display  
10 apparatus of the embodiment are roughly similar to those of the Example 1. However, the voltage supplying structure is changed to a structure shown in Fig. 5.

As a power supply mechanism from an atmosphere  
15 to the image display apparatus 105 which is vacuum inside, a voltage supplying structure 100 is provided. Fig. 5 is a sectional view of Example 2, which is equivalent to the line A-A portion of Fig. 1. A voltage is applied from the backside of a rear plate  
20 102 through a hole 111 to a conductive member 208, and applied through a low melting point material 107 to an anode 104.

The voltage supplying structure 100 comprises the conductive member 208, the low melting point  
25 material 107, and a bonding member 109. A diameter of the hole 111 bored in the rear plate is about 2 mm.

The low melting point material 107 is disposed

between the conductive member 208 and the anode 104. The low melting point material improves conductivity by enhancing adhesion between the conductive member 208 and the anode 104. As a low melting point  
5 material, Sn-Pb solder (melting point 180 to 330°C) of a low melting point metal material is used. The low melting point material is compressed and deformed between the conductive member 208 deformed by a atmospheric pressure and the anode 104, stuck to the  
10 surface shape of the conductive member 208 and the anode 104, and thus capable of improving electrical conductive reliability.

Further, when the image display apparatus 105 is influenced by an unexpected surrounding  
15 temperature to be deformed by thermal expansion, adhesion between the conductive member 208 and the anode 104 may be deteriorated. In such a case, by applying a high-frequency voltage to the conductive member 208, and generating heat to melt the low  
20 melting point material 107, it is possible to improve adhesion between the conductive member 208 and the anode 104 without disassembling the image display apparatus 105.

Vacuum airtightness is secured by using a  
25 bonding member 109 to bond the conductive member 208 and the anode 104. As a material of the bonding member 109, a frit which is low melting point glass

is used. A mixture of a frit and a solvent is applied on the conductive member 208 by a dispenser, dried (120°C, 10 min.), and temporary burning (360°C, 10 min.) is carried out. Then, in a real burning  
5 step (420°C, 30 min.), the conductive member 208 is placed on the rear plate 102, and a load is applied on the conductive member 208 to crush the temporarily burned frit while a temperature is increased. Thus, good bonding is obtained.

10 The conductive member 208 is an integral member constituted of an adhesive portion of a diameter 4 mm and an elongation portion. A material is a 47% Ni-Fe alloy (thermal expansion coefficient  $7.5 \times 10^{-6}/^{\circ}\text{C}$  to  $9 \times 10^{-6}/^{\circ}\text{C}$ ). It is roughly matched with thermal  
15 expansion of glass (thermal expansion coefficient  $8.0 \times 10^{-6}/^{\circ}\text{C}$  to  $9.0 \times 10^{-6}/^{\circ}\text{C}$ ) used for the rear plate 102 to reduce thermal stress during manufacturing. The conductive member 208 is bonded to the rear plate 102 by the bonding member 109. Since only one place  
20 between the conductive member 208 and the rear plate 102 can be a bonded portion of the voltage supplying structure 100, it is possible to limit a probability of leakage or a strength reduction caused by bonding failures.

25 The conductive member 208 is manufactured by sucking a plate of 10 mm in diameter and 0.05 mm in thickness in a mold by air, and executing press-

molding. A shape is a circle of an outer diameter of about 4 mm when the image display apparatus 105 is seen from the anode 104 side. A height is about 0.7 mm, which is smaller than a gap length 2 mm between the rear plate 102 and the face plate 101. As shown in Fig. 6A, the conductive member 208 is bonded to the rear plate 102 by the bonding member 109. Then, as shown in Fig. 6B, the frame 103 is pinched in between the rear plate 102 and the face plate 101, and the rear plate and the frame, and the frame and the rear plate are sealed from each other by frits. Then, a vacuum is drawn through the not-shown exhaust pipe between the rear plate 102 and the face plate 102, sealing is applied, and accordingly a vacuum container is manufactured. At this time as shown in Fig. 6C, the conductive member 208 is elongated to the gap length 2 mm between the rear plate 102 and the face plate 101 by an influence of an atmospheric pressure from the hole 111. Thus, it is possible to realize a shape to be made conductive with the anode 104 through the low melting point material 107.

In the conductive member 102, a plurality of concave and convex shapes can be formed in the elongation section on the side face by press-molding without much time and labor, and it is possible to control deformation of the conductive member 208 by the atmospheric pressure in a direction of the anode

104. As a result, it is possible to improve  
conductive reliability between the conductive member  
208 and the anode 104. Furthermore, as the portion  
of the conductive member 208 bonded to the rear plate  
5 102, a constitution is employed in which a surface  
opposite the surface bonded to the rear plate 102 by  
the bonding member 109 is exposed to an atmospheric  
pressure atmosphere as an external atmosphere, and a  
structure is employed in which the portion of the  
10 conductive member 208 bonded to the rear plate 102 is  
pressed by the atmospheric pressure to the rear plate  
102 side as the bonding target. Thus, it is possible  
to improve vacuum airtightness of the bonded surface.

### Example 3

15 A vacuum container and an image display  
apparatus of the embodiment are roughly similar to  
those of Example 1. However, the voltage supplying  
structure is changed to a structure shown in Fig. 7.

As a power supply mechanism from an atmosphere  
20 to the image display apparatus 105 which is vacuum  
inside, a voltage supplying structure 100 is provided.  
Fig. 7 is a sectional view of the third embodiment,  
which is equivalent to the line A-A portion of Fig. 1.  
A voltage is applied from the backside of a rear  
25 plate 102 through a hole 111 to a conductive member  
308, and applied through a low melting point material  
107 to an anode 104.

The voltage supplying structure 100 comprises the conductive member 308, the low melting point material 107, and a bonding member 109. A diameter of the hole 111 bored in the rear plate is about 2 mm.

5       The low melting point material 107 is disposed between the conductive member 308 and the anode 104. The low melting point material improves conductivity by enhancing adhesion between the conductive member 308 and the anode 104. As a low melting point  
10 material, an Sn-Cu alloy (melting point 200 to 350°C) of a low melting point metal material is used. The low melting point material is compressed and deformed between the conductive member 308 deformed by an atmospheric pressure and the anode 104, stuck to the  
15 surface shape of the conductive member 308 and the anode 104, and thus capable of improving electrical conductive reliability.

Further, when the image display apparatus 105 is influenced by an unexpected surrounding  
20 temperature to be deformed by thermal expansion, adhesion between the conductive member 308 and the anode 104 may be deteriorated. In such a case, by applying a high-frequency voltage to the conductive member 308, and generating heat to melt the low  
25 melting point material 107, it is possible to improve adhesion between the conductive member 308 and the anode 104 without disassembling the image display

apparatus 105.

Vacuum airtightness is secured by using a bonding member 109 to bond the conductive member 308 and the anode 104. As a material of the bonding member 109, a frit which is low melting point glass is used. A mixture of a frit and a solvent is applied on the conductive member 308 by a dispenser, dried (120°C, 10 min.), and temporary burning (360°C, 10 min.) is carried out. Then, in a real burning step (420°C, 30 min.), the conductive member 308 is placed on the rear plate 102, and a load is applied on the conductive member 308 to crush the temporarily burned frit while a temperature is increased. Thus, good bonding is obtained.

The conductive member 308 is an integral member constituted of an adhesive portion of a diameter 4 mm and an elongation portion. A material is a 47% Ni-Fe alloy (thermal expansion coefficient  $8 \times 10^{-6}/^{\circ}\text{C}$  to  $9.5 \times 10^{-6}/^{\circ}\text{C}$ ). It is roughly matched with thermal expansion of glass (thermal expansion coefficient  $8.0 \times 10^{-6}/^{\circ}\text{C}$  to  $9.0 \times 10^{-6}/^{\circ}\text{C}$ ) used for the rear plate 102 to reduce thermal stress during manufacturing. The conductive member 308 is bonded to the rear plate 102 by the bonding member 109. Since only one place between the conductive member 308 and the rear plate 102 can be a bonded portion of the voltage supplying structure 100, it is possible to limit a probability



of leakage or a strength reduction caused by bonding failures.

The conductive member 308 is manufactured by sucking a plate of 9 mm in diameter and 0.05 mm in thickness in a mold by air, and executing press-molding. A shape is a circle of an outer diameter of about 4 mm and a tip diameter of 0.5 mm when the image display apparatus 105 is seen from the anode 104 side. A height is about 1.5 mm, which is smaller than a gap length 2 mm between the rear plate 102 and the face plate 101. As shown in Fig. 8A, the conductive member 308 is bonded to the rear plate 102 by the bonding member 109. Then, as shown in Fig. 8B, the frame 103 is pinched in between the rear plate 102 and the face plate 101, and the rear plate and the frame, and the frame and the rear plate are sealed from each other by frits. Then, a vacuum is drawn through the not-shown exhaust pipe between the rear plate 102 and the face plate 102, sealing is applied, and accordingly a vacuum container is manufactured. At this time as shown in Fig. 8C, the conductive member 308 is elongated to the gap length 2 mm between the rear plate 102 and the face plate 101 by an influence of an atmospheric pressure from the hole 111. Thus, it is possible to realize a shape to be brought into contact with the anode 104 through the low melting point material 107.

Since a crushing area of the low melting point material 107 between the conductive member 308 and the anode 104 is reduced, it is possible to increase a pressure per unit on the low melting point material 107 applied by the atmospheric pressure. As a result, it is possible to improve conductive reliability between the conductive member 308 and the anode 104.

Example 4

A vacuum container and an image display apparatus of the embodiment are roughly similar to those of the Example 1. However, the voltage supplying structure is changed to a structure shown in Fig. 9.

As a power supply mechanism from an atmosphere to the image display apparatus 105 which is vacuum inside, a voltage supplying structure 100 is provided. Fig. 9 is a sectional view of the second embodiment, which is equivalent to the line A-A portion of Fig. 1. A voltage is applied from the backside of a rear plate 102 through a hole 111 to a conductive member 408, and applied through a low melting point material 107 to an anode 104.

The voltage supplying structure 100 comprises the conductive member 408, the low melting point material 107, and a bonding member 109. A diameter of the hole 111 bored in the rear plate is about 2 mm.

The low melting point material 107 is disposed

between the conductive member 408 and the anode 104. The low melting point material improves conductivity by enhancing adhesion between the conductive member 408 and the anode 104. As a low melting point material, an Sn-Ag alloy (melting point 200 to 350°C) of a low melting point metal material is used. The low melting point material is compressed and deformed between the conductive member 408 deformed by a atmospheric pressure and the anode 104, stuck to the surface shape of the conductive member 408 and the anode 104, and thus capable of improving electrical conductive reliability.

Further, when the image display apparatus 105 is influenced by an unexpected surrounding temperature to be deformed by thermal expansion, adhesion between the conductive member 408 and the anode 104 may be deteriorated. In such a case, by applying a high-frequency voltage to the conductive member 408, and generating heat to melt the low melting point material 107, it is possible to improve adhesion between the conductive member 408 and the anode 104 without disassembling the image display apparatus 105.

Vacuum airtightness is secured by using a bonding member 109 to bond the conductive member 408 and the anode 104. As a material of the bonding member 109, a frit which is low melting point glass

is used. A mixture of a frit and a solvent is applied on the conductive member 408 by a dispenser, dried (120°C, 10 min.), and temporary burning (360°C, 10 min.) is carried out. Then, in a real burning  
5 step (420°C, 30 min.), the conductive member 408 is placed on the rear plate 102, and a load is applied on the conductive member 408 to crush the temporarily burned frit while a temperature is increased. Thus, good bonding is obtained.

10       The conductive member 408 is an integral member constituted of an adhesive portion of a diameter 4 mm and an elongation portion. A material is a an Fe-Ni-Co alloy (thermal expansion coefficient  $7.5 \times 10^{-6}/^{\circ}\text{C}$  to  $9.8 \times 10^{-6}/^{\circ}\text{C}$ ). It is roughly matched with thermal  
15 expansion of glass (thermal expansion coefficient  $8.0 \times 10^{-6}/^{\circ}\text{C}$  to  $9.0 \times 10^{-6}/^{\circ}\text{C}$ ) used for the rear plate 102 to reduce thermal stress during manufacturing. The conductive member 408 is bonded to the rear plate 102 by the bonding member 109. Since only one place  
20 between the conductive member 408 and the rear plate 102 can be a bonded portion of the voltage supplying structure 100, it is possible to limit a probability of leakage or a strength reduction caused by bonding failures.

25       The conductive member 408 is manufactured by sucking a plate of about 10 mm in diameter and 0.1 mm in thickness in a mold by air, and executing press-

molding. A shape is a circle of an outer diameter of about 4 mm when the image display apparatus 105 is seen from the anode 104 side. A height is about 0.6 mm, which is smaller than a gap length 2 mm between the rear plate 102 and the face plate 101. As shown in Fig. 10A, the conductive member 408 is bonded to the rear plate 102 by the bonding member 109. Then, as shown in Fig. 10B, the frame 103 is pinched in between the rear plate 102 and the face plate 101, and the rear plate and the frame, and the frame and the rear plate are sealed from each other by frits. Then, a vacuum is drawn through the not-shown exhaust pipe between the rear plate 102 and the face plate 102, sealing is applied, and accordingly a vacuum container is manufactured. At this time as shown in Fig. 10C, the conductive member 408 is elongated to the gap length 2 mm between the rear plate 102 and the face plate 101 by an influence of an atmospheric pressure from the hole 111. Thus, it is possible to realize a shape to be made conductive with the anode 104 through the low melting point material 107.

Since the conductive member 408 is formed in the circular in an in-plane direction of the rear plate 102, a uniform atmospheric pressure is generated on the circle, and it is possible to control deformation of the conductive member 408 in a direction of the anode 104. As a result, it is

possible to improve conductive reliability between the conductive member 408 and the anode 104.

Furthermore, since a structure is employed in which the surface of the conductive member 408 to the rear  
5 plate 102 by the bonding member 109 is pressed by the atmospheric pressure, it is possible to improve vacuum airtightness of the bonded surface.